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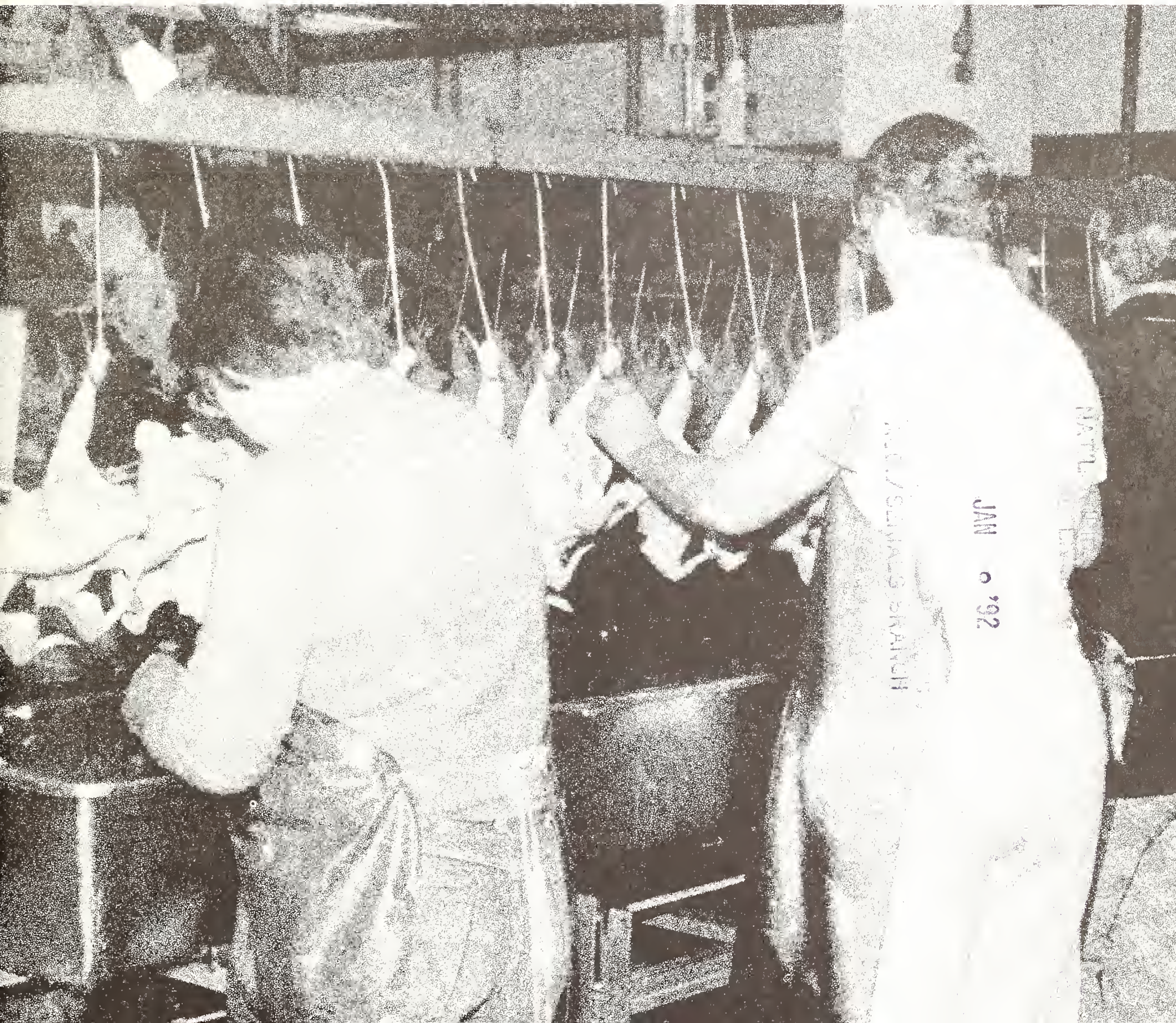

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May 1986

Summary

Between 1943 and 1983, broiler production in the United States increased by almost 15 billion pounds, and productivity increased extensively in both production and processing. Mechanization of numerous slaughtering, defeathering, and eviscerating functions has improved efficiency enough to create much interest, both within the poultry industry and outside. However, productivity increases have not been evenly distributed throughout the processing plants, and productivity has improved little in the packing department, except that the bagged product is more attractively packaged. Lack of uniformity at different plants in the methods and equipment for packing broilers is not conducive to developing automated equipment, and some automated equipment that has been developed has not been widely adopted.

Bird packing operations were observed in commercial broiler processing plants, and one was selected from the industry to exemplify the way packing productivity could be improved in an existing plant with only a minimal investment and disruption of daily operations.

In the study plant, broilers are icepacked or bagged and boxed on the same packing line. Items of equipment are moved from storage to a position on the line, or vice versa, as needed to make the changeover from bagging to icepacked, or back to bagging. Conversion from one packing system to the other normally requires about 15 minutes. At the time of the study, giblets were being packed in the body cavities of the icepacked birds but were not packed in the body cavities of the bagged birds, many of which were being packed for institutional markets. Versatility of packaging to meet customer preferences is considered by management to be a necessary requirement to maintain or improve sales. Time lost during changeover reduced productivity.

In the icepacked product, 22 or 23 unwrapped birds are packed with giblets in a wax-impregnated fiberboard box of partial telescoping design and covered with water ice. In the bagged product, each bird is enclosed in a sealed bag, and either 12 or 16 of the individually enclosed birds are packed in a full-telescoping-design box.

At the present operating speed of 4,800 birds per hour, 44 people are achieving a productivity rate of 109 birds per worker-hour when either icepacking or bagging and boxing. With the improved icepacking layout of facilities and work stations and some additional equipment, an estimated 28 people could achieve the same total output per hour for a productivity rate of 171 birds per worker-hour.

Through implementation of the bagging and boxing layout with automatic bagging machines, an estimated 27 people can achieve a productivity rate of 178 birds per worker-hour when operating at 4,800 birds per hour. Estimated additional facility and equipment costs are $36,825 for the icepacking line and $97,500 for the bagging and boxing line, both of which are feasible investments in the study plant at the present or increased volume. Some of the new equipment can be used for both products.

Introduction

Within the last four decades, the broiler industry has grown from 736.4 million pounds ready-to-cook (RTC) to 15.5 billion pounds RTC (*1*)(*2*)[1], a twentyfold increase. During this period, productivity has increased extensively in the poultry industry, in both production and processing. In the processing segment of the industry, productivity increases are primarily attributable to economies of scale associated with increases in product volume per plant and to mechanization of numerous processing functions. However, productivity has not increased uniformly among the many functions usually performed in converting live birds on the farm into processed product in its many forms, ready for distribution to consumer outlets. Typically, poultry processing plants have expanded the volume of product by 20 percent or more without increasing the number of personnel who perform slaughtering, defeathering, or eviscerating functions, but gains in packing and further-processing functions have necessitated more personnel.

Uniformity of functions has helped facilitate mechanization, particularly in the evisceration functions. Since each bird is eviscerated like the previous one, and the evisceration process is carried out in essentially the same sequence in most plants, a machine that will perform a needed function has industrywide application. Research conducted by the U.S. Department of Agriculture (*3*) determined the most efficient evisceration levels and sequence of operation and contributed to uniformity throughout the industry.

The packing operations in poultry plants are not as efficient as are evisceration operations, requiring more personnel for packing as the plant volume has grown. It is not unusual that more personnel are required for packing and further processing (includes cutting up or dismembering the whole bird) than are required to operate the remainder of the plant. The way birds are packed is not uniform between plants; therefore, mechanization of packing functions has progressed relatively slowly. Equipment manufacturers have been unable to justify the cost for research and development of intricate machinery when the absence of standardization necessitates customized packing equipment for each plant. Equipment manufacturers must perceive a potential market before allocating resources to the development of automated equipment.

Some specialized equipment has been developed and is being used to achieve various levels of efficiency in numerous plants. Examples of equipment in use include giblet wrappers; giblet pumps; giblet cleaning equipment; neck breakers; automatic weighing, printing, labeling, and recording scales; pallet transporters; conveyors; shrink tunnels, and clip ties. Even with all of this and other special equipment, packing operations require more personnel than eviscerating operations on a per-function basis.

The purpose of this study was to analyze systems for packing whole, ready-to-cook broilers and to develop and incorporate economically feasible improvements in the systems to increase their level of efficiency. A broiler or fryer is a young chicken, usually under 13 weeks old, of either sex. It has tender meat, with soft, pliable, smooth-textured skin and flexible breastbone cartilage (*4*). In recent years broilers have reached 4 pounds at less than 50 days of age. Systems analyzed and improved consisted of (a) an icepacking line for whole birds in which wrapped or bagged giblets are stuffed into the body cavity, and the carcasses are packed into boxes and covered with ice or carbon dioxide (CO_2) and (b) whole birds encased in plastic bags and packed in boxes. Usually excess air is removed from the bags by a vacuum machine or by squeezing. Then the bags are closed with tape or a clip. Some bagged products may be put through a shrink tunnel to shrink the film to fit the conformation of the bird. Bagged birds are packed without giblets in some plants, as they were in the plant selected for use as an example, but in others the giblets are included.

[1]Numbers in parentheses refer to literature cited on page 22.

Procedure

Packing operations were observed in broiler processing plants to gather background information on the combinations of work methods and equipment commonly used in the industry. Packing and grading operations in randomly selected commercial plants were analyzed by time study methods to determine average labor requirements, by function, when various methodologies and equipment are used. Based on productivity data gathered from the randomly selected plants, one of the plants was chosen to exemplify the way productivity could be improved in plants that use similar work methods and equipment.

Because some poultry processors pack numerous types of products, a study of all of the types of products and packages would be of excessive length and of limited benefit to the industry. The scope of this study is, therefore, limited to whole broilers. Broilers are packed as icepacked whole birds or bagged, whole birds.

Many "best ways" for performing each of the job assignments in the packing operation were found. For development of acceptable criteria as to which methods were actually best under various operating conditions, motion and time studies were conducted based on average workers.[2] Motion and time study is the branch of knowledge that deals with the scientific determination of preferable work methods; an appraisal, in terms of time, of the value of work involving human activity; and the development of material required to make practical use of these data (*5*).

The motion study phase may be more fully defined as a procedure for scientific analysis of work methods—considering (a) the raw materials, (b) the design of the product, (c) the process or order of work, (d) the tools, workplace, and equipment for each individual step in the process, and (e) the hand and body motions used in each step in the process—to determine a preferable work method.

The time study phase may be defined as a procedure for determining the amount of time required, under certain standard conditions of measurement, for tasks that involve some human activity.

Each change in grading, handling, and packing methodology and equipment was evaluated with either motion and time studies or application of the methods-time-measurement (MTM) analysis technique (*6*)(*10*). This technique is described in the appendix of this report.

[2]Individuals capable of performing acceptable work at a normal rate for an extended period of time. Includes 15 percent allowance for fatigue and personal time.

Description of the Icepacking Operation

Whole, ready-to-cook carcasses packed in ice were the predominant form in which broilers were marketed a few years ago, and, although the percentage marketed in this form has declined, it still constitutes 15 percent or more of the total broilers marketed in this country. Typically, 22 to 23 broilers are packed in wirebound wooden boxes; wax-coated corrugated-fiberboard boxes; resin-wax-impregnated corrugated-fiberboard boxes; or expanded-polystyrene boxes. Then the birds are covered with a coolant, such as water ice, dry-ice snow, or dry ice (*7*).

The plant in this study uses the wax-impregnated corrugated-fiberboard boxes of partial-telescope design with inside dimensions of 21 by 17 by 10 inches (fig. 1). Each end of these boxes has two drainage holes, 0.85 inch in diameter. The average tare weight of the boxes was 3.5 pounds, and the weight range was 3.3 to 3.6 pounds. The broilers were placed in the boxes breast up and legs toward the center, two layers per box. Similar boxes are used in other plants (*8*).

Packing lines normally operate at a relatively slow speed, similar to the speed of evisceration lines; therefore, multiple packing lines are needed to handle the volume of product generated by each slaughtering line. The packing line in the plants analyzed in this study operated at about 80 birds per minute (4,800 birds per hour).

In most plants, the packing department is separate from the evisceration department, even though the two departments may operate within one single large room or area of the plant. When the birds are removed from

Figure 1.—Wax-impregnated, partial-telescoping fiberboard-box for icepacked poultry.

the evisceration shackles, they become the responsibility of the packing department. The first function of the packing department, cooling the birds or removing the body heat, is accomplished automatically. Birds are mechanically removed from the evisceration shackles and dropped into a continuous chiller. After cooling, the birds are deposited on drain racks.

The study plant has four packing lines, all located within a single room and all running parallel to each other. On three of the lines, various cutting-up or further-processing operations, or both, are performed before packing.

Periodically, the form of the whole-bird packing line is changed to fill orders for different products; therefore, versatility is a requirement. A changeover in line form takes between 10 and 15 minutes now. Sufficient space must be allowed for the performance of each operation, even though an operation may not always be performed. For example, sufficient space must be allowed for packing and stuffing giblets, although, when the market dictates, the birds are packed without giblets.

All whole-bird packing operations and functions shown in figure 2, with the exception of USDA grading, were evaluated during the study. The whole-bird packing line normally operates at about 4,800 birds per hour, with a maximum output of 5,000 birds per hour with the present personnel, methodology, and equipment. The level of staffing and the quality and uniformity of bird size influence the level of output; however, with excessive staffing, output usually does not exceed 5,000 birds per hour.

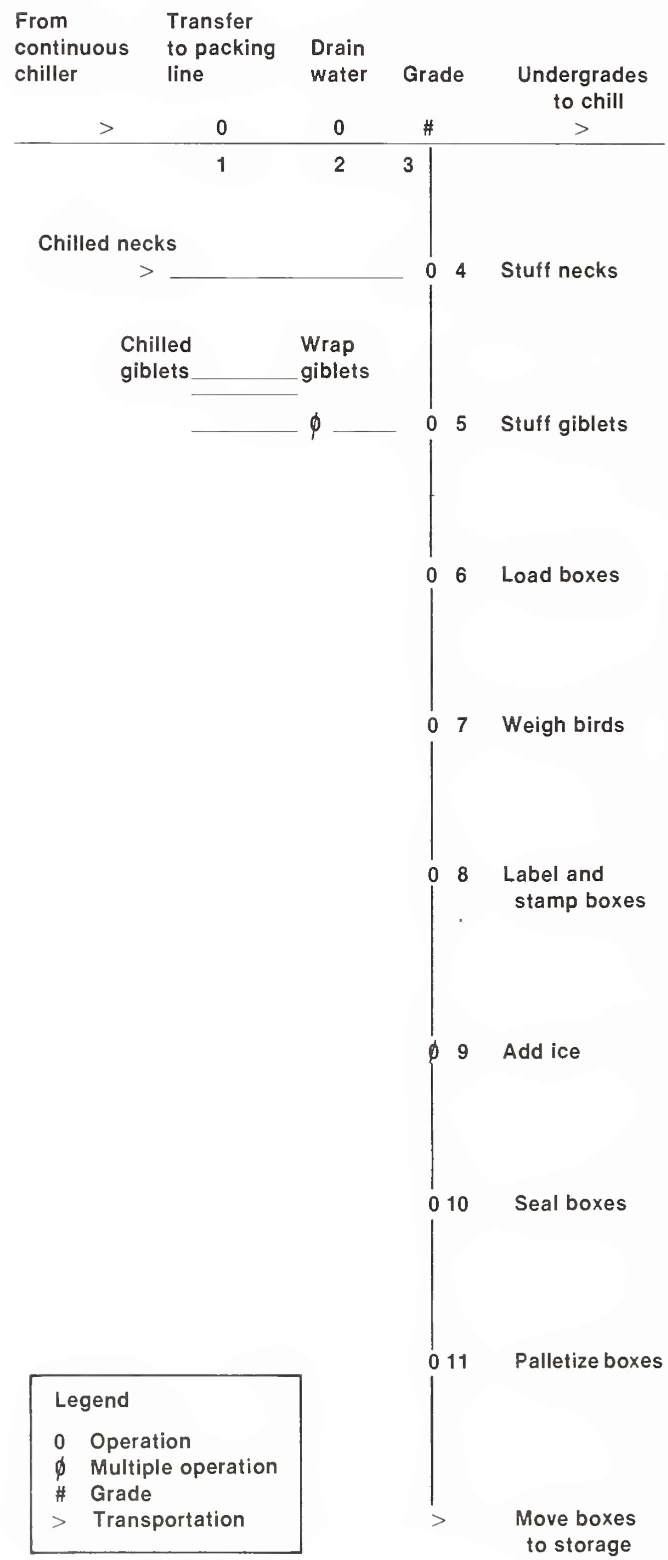
Hanging and Grading

Figure 3 illustrates the arrangement of the present ice-packing line. Three workers are responsible for placing birds in shackles attached to the overhead conveyor that moves the birds from the evisceration room to the packing room and past the grading station. At the grading station, birds that do not meet the standards are removed from the shackles and placed in a portable bin. The grading station is equipped with a 2- by 2-foot mirror to enable the grader to see the back of the birds without turning them. An 18-inch-wide belt conveyor is located under the overhead conveyor. The top of the belt conveyor is 34 inches above the floor, and the shackles are 57 inches above the floor. The belt conveyor is a food-grade surface and is equipped with a continuous cleaning-spray wash mechanism.

Neck Stuffing

After grading, the birds are conveyed, on a belt conveyor, past three workers. Each of those workers stuffs a neck into the body cavity of each third bird on the

Figure 2. Flow process chart of broiler-icepacking operations.



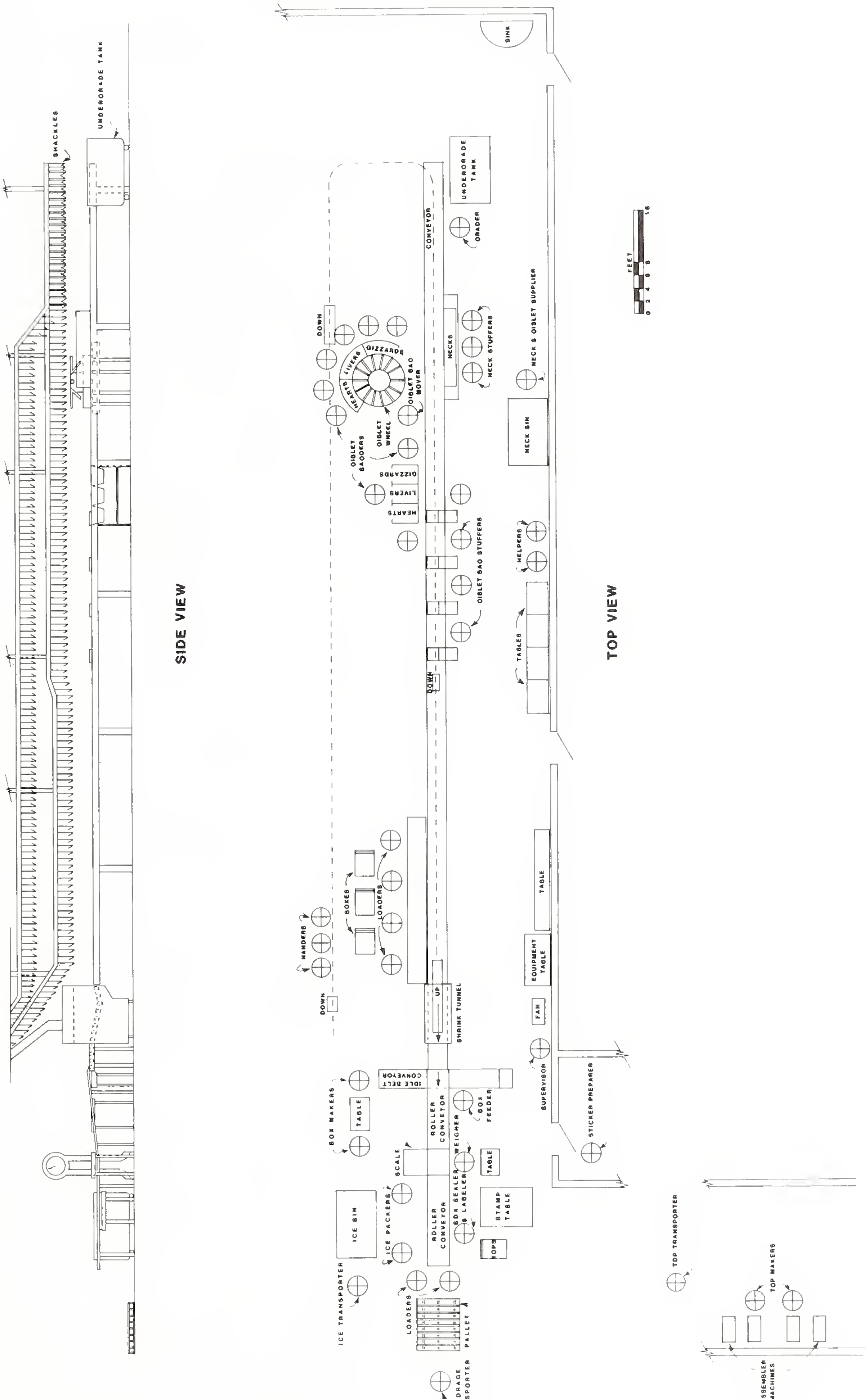


Figure 3.—Arrangement of facilities and work stations on icepacking line.

conveyor. Another worker supplies necks to the stuffers from a chill tank by placing the necks in a 1- by 1-by 6-foot container located between the stuffers and the belt conveyor. The top of the container is level with the belt conveyor.

Giblet Packing
Giblets are packed in small white bags with the aid of a giblet wheel (fig. 3). The giblet wheel has a radius of 2 feet and contains 14 bins, each of which is 1 foot deep and 1 foot wide, for holding a supply of giblets and bags. Hearts, livers, and gizzards are not commingled in bins. Six workers place giblets in bags, and another worker removes the bags of giblets from the wheel and places them on the belt conveyor. Any bag without a complete set of giblets goes around the wheel again. Three more workers pack giblets along the belt conveyor. The first worker picks up a bag and a heart and places the heart in the bag. That worker then places the bag in a tub in front of the second worker, who adds a liver to the bag. Then the second worker places the bag in front of the third worker, who adds a gizzard and places the bag on the belt conveyor.

Giblet Stuffing
As the bagged giblets are transported by the belt conveyor, they pass before four workers, each of whom stuffs a bag of giblets into the body cavity of each fourth bird on the overhead conveyor. Excess bags of giblets are stored in pans temporarily until the supply of birds exceeds the supply of bagged giblets. Two other workers, who are assistant supervisors, help bag and stuff giblets when needed. The worker who supplies necks to the stuffers also help supply giblets.

Box Packing
Four workers remove birds from the shackles attached to the overhead conveyor and place them in fiberboard boxes located on a table between them and the belt conveyor. The overhead conveyor is 4 inches lower at the packing station than at other points along the line for ease in removing birds from the shackles. Approximately 23 broilers are packed in each box. Then the filled box is pushed onto the belt conveyor and transported through the nonoperating shrink tunnel to a roller conveyor. (The steam valves on the shrink tunnel are closed when birds are being icepacked.) Stacks of empty boxes are located behind the workers filling the boxes. The boxes are assembled (formed and stapled) by two other workers at a nearby location.

Box Weighing and Labeling
One worker manually moves boxes of broilers by the box feeder through the shrink tunnel and along the roller conveyor. Another worker weighs the boxes of broilers on the platform scales, where the weight is adjusted to approximately 55 pounds by substituting heavier or lighter birds. A reserve supply of broilers is located on the table behind the weigher (fig. 3). When the weight has been adjusted properly, the box is pushed along a roller conveyor to the box sealer and labeler who identifies the product with a label and the appropriate rubber stamp. Then two other workers shovel ice from a stainless steel tank into each box. The quantity of ice placed in a box varies, depending on the season of the year and anticipated storage conditions. Next, the box sealer and labeler attaches a label to the telescoping box top. Tops are assembled by two other workers located in another area of the plant, necessitating an additional worker to transport the tops to the point of use. Labels are prepared by a worker located in an adjacent room.

Loading and Transporting
Four workers close and stack the boxes six levels high, six boxes per level, on a wooden pallet. Another worker moves the pallets of product to storage with an electric pallet transporter (or jack), and an additional worker moves tanks of ice from the ice room to the packing area.

Supervision and Support
A supervisor and two assistants manage the whole-bird packing operation, including substituting for workers on breaks and supplying materials and product as needed along the line.

Total Labor Requirements

The labor requirements, by function and productivity rates, are shown in table 1 for icepacking 4,800 birds per hour in the study plant. Of the 44 people working in the packing department, approximately 15 percent were trainees throughout the study period. Management indicates that this percentage was normal because of the high turnover rate. The packing productivity rate is 109 birds per worker-hour. A factor contributing to the level of productivity at the study plant is the time lost for frequent changes in type of packages requested by different customers. The above production rate of 109 birds per worker-hour includes a 10-percent allowance for lost time and fatigue.

Table 1.—Labor requirements, by function and productivity rates, to icepack 4,800 broilers per hour[1]

Function	Number of workers	Birds per worker-hour [2]	Birds per worker-minute [3]	Worker-minutes per 100 birds [4]	Worker-hours per 1,000 birds [5]	Worker-hours per 100 boxes [6]
Hang birds in shackles	3	1,600	26.7	3.75	0.63	1.44
Grade birds	1	4,800	80.0	1.25	.21	.48
Stuff necks	3	1,600	26.7	3.75	.63	1.44
Bag giblets	9	533	8.9	11.25	1.88	4.31
Stuff giblets	4	1,200	20.0	5.00	.83	1.92
Move bags and supplies	2	2,400	40.0	2.50	.42	.96
Make and transport boxes	5	960	16.0	6.25	1.04	2.40
Load boxes	4	1,200	20.0	5.00	.83	1.92
Feed, weigh, and label boxes	3	1,600	26.7	3.75	.63	1.44
Ice boxes and transport box tops	3	1,600	26.7	3.75	.63	1.44
Load boxes on pallets	2	2,400	40.0	2.50	.42	.96
Transport boxes to storage	1	4,800	80.0	1.25	.21	.48
Prepare labels	1	4,800	80.0	1.25	.21	.48
Supervise and assist	3	1,600	26.7	3.75	.63	1.44
Total or average	44	109.09	1.82	55.00	9.20	21.11

[1] 23 birds per box.
[2] Number of birds packed per hour, divided by number of workers.
[3] Birds per worker-hour, divided by 60 minutes.
[4] 100 birds, divided by birds per worker-minute.
[5] 1,000 birds, divided by birds per worker-hour.
[6] 100 boxes, 23 birds each, divided by total birds packed per hour, and the dividend multiplied by the number of workers.

Description of the Bird Bagging Operation

The trend in poultry marketing has been and continues to be the marketing of products in a value-added form, or at least in a form that is not messy, difficult, or unattractive for consumers or retailers to handle. Of the 12 billion pounds of ready-to-cook (RTC) young chicken meat certified by federally inspected plants in 1982, approximately 7.3 billion pounds were cutup or further processed, leaving 4.7 billion pounds sold as RTC whole birds (*1*). Additionally, processors have sought to minimize the quantity of products shipped as icepacked because of increased transportation costs. This trend has led to an increase in broilers marketed as whole, ready-to-cook carcasses, either in bags designed to fit some of the contours of the carcass or in heat-shrinkable bags. Most of the birds packed for store sales include giblets, whereas most of those destined for institutional sales are packed without giblets.

Bagged birds are usually packed in fiberboard boxes, each containing 12 or 16 birds (fig. 4) as specified by the customer. The boxes are perforated to improve air circulation, since mechanical refrigeration is usually required to maintain product quality. Each bird is weighed and labeled individually and boxed according to weight class. Some of them are prepriced. Each bird is manually placed in a box, breast up, with legs toward the center of the box.

All packing operations shown in figure 5 with the exception of USDA grading, were evaluated in the study. Figure 6 illustrates the arrangement of facilities and work stations on the bagging line in the study plant. The function performed at each step and the facilities used in the performance of those functions are described

Figure 4.—A full-telescoping fiberboard box for bagged poultry.

Figure 5.—Flow process chart for broiler-bagging operation.

Transfer to packing line 0 >	Drain water and ice 0	Grade #	Undergrades to chill
1	2	3	
	> ____	0 4	Stuff necks
	> ____ ø ____ > ____ Wrap giblets	0 5	Stuff giblets
	To conveyor	0 6	Bag birds
		0 7	Fold legs
		0 8	Seal birds
		0 9	Weigh and label birds
	> ____ Supply boxes	0 10	Box birds
	> ____ Supply lids	0 11	Record weight, attach lid
		ø 12	Stamp boxes, attach labels
		0 13	Palletized boxes
		>	To storage

Legend
0 Operation
ø Multiple operation
Grade
> Transportation

in the following paragraphs. The bagging line is operated at 4,800 birds per hour, and the maximum output sustainable with the present personnel, methodology, and equipment is 5,000 birds per hour, the same as for the icepacking line.

Hanging
Three people remove birds from the drain rack and hang them by one leg on J hooks attached to a continuous overhead conveyor. Most of the time, a supply of chilled birds is available from a chill tank to add to inadequate supplies coming from the continuous chiller. Conversely, when excess birds come from the chiller, they are dropped into a nearby chill tank from which they are to be hung on the conveyor when needed.

Draining
Birds are transported from another area of the plant to the packing department while suspended from the overhead conveyor. They drain as they are transported for a distance of about 160 feet. When the birds are to be bagged, one or two workers remove ice and fat tissue from the neck opening to the body cavity. The J hooks are 5 feet above the floor at this work station to permit easy examination of the carcasses. Drainage continues as the birds are moved to the grading station.

Grading
Each bird is examined by a USDA grader, who removes undergrade birds and drops them into a chill tank located nearby (fig. 6). The work station is equipped with a 2- by 2-foot mirror placed behind the birds, which pass through the station suspended 5 feet above the floor. Also, extra lights are provided to improve accuracy in grading. Approximately 100 foot-candles of light are provided by the 48-inch, fluorescent-type fixtures. The birds are counted, before and after grading, by photoelectric counters.

Bagging
After grading, the birds move above an 18-inch-wide belt, 34 inches above the floor, while suspended from the overhead conveyor. They pass in front of seven people who place absorbent pads and bags on them. Typically, an absorbent pad is pressed against the back and neck area of each bird, where it adheres temporarily. Next, a bag is taken from a reserve supply, on a removable rack fitted across the belt conveyor, and pulled onto the bird, enclosing both the bird and the absorbent pad. Sometimes the pad is inserted into the bag just before the bag is pulled onto the bird.

Bag Sealing
At the next work station, eight workers remove the bagged birds from the shackles and shape them by pushing

their legs down and forward. Birds are pushed well into the bags, and excess air is removed either by using a vacuum process or by manually pressing the air out. The open end of the bag is then twisted and placed in a bag-sealing machine that wraps tape around the twisted portion of the bag and cuts off the excess bag material. The bagged birds are placed on the 18-inch-wide belt conveyor and transported to the shrink tunnel. Even when nonshrinkable bags are used, the birds are conveyed through the shrink tunnel, but with the steam turned off.

Weighing and Classing
When bagged birds exit the shrink tunnel, they are deposited on a 10-foot-long belt conveyor, which is perpendicular to the shrink tunnel conveyor. A worker pushes birds from the conveyor onto a table, maintaining an even distribution of birds along the table so the three workers feeding the scale will have easy access. Those three workers supply one bird at a time to the scales to be weighed. Birds are individually weighed, labeled, and placed in a box, according to weight class, by three additional people.

Nine boxes are located at each weighing station. The boxes are arranged on a three-level rack, and the position of each box indicates its weight class. Three workers stand on the opposite side of the rack from the weighers, removing the filled boxes and replacing them with empty boxes. After placing each full box on the roller conveyor for final packing, the box movers mark the weight class on an empty box and place it in the position to be filled.

Box Sealing and Labeling
The box sealer, the first worker on the final packing section, notes the weight class and places a top on

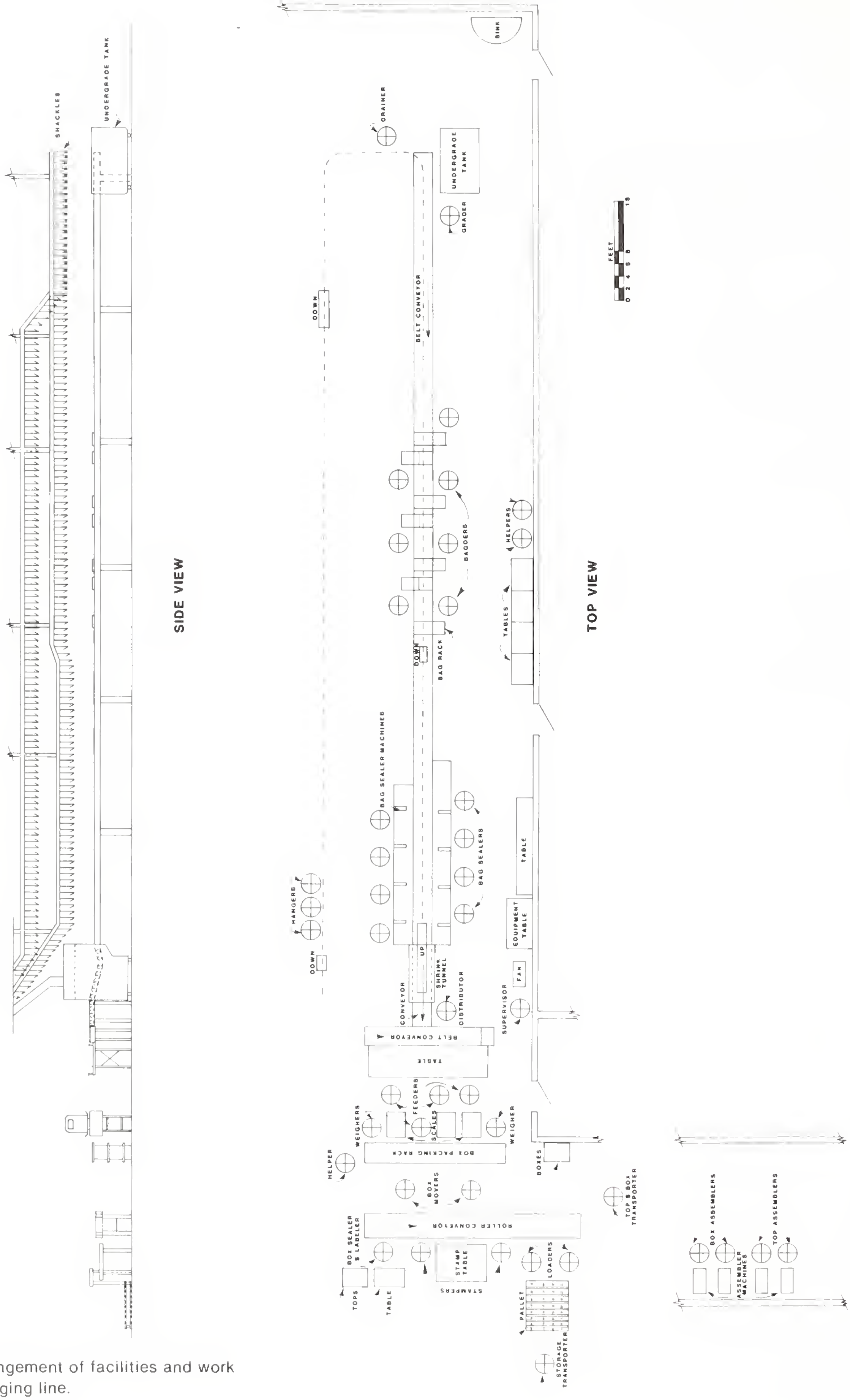


Figure 6.—Arrangement of facilities and work stations on bagging line.

each box, covering the weight designation written by the box movers. Next, a second person stamps it with the weight class as told to him by the box sealer. A third worker labels the box with a warning to keep the contents chilled and pushes the box to the end of the conveyor, where two workers move the boxes to pallets.

Loading and Transporting

The pallets are loaded, six boxes to a level, and stacked eight levels high. "Two-by-four" lumber is used to separate the levels to facilitate air movement between the boxes and to enable rapid cooling of the product in the cooler or freezer. The stack is moved, with an electric pallet jack, to cold storage.

Supervising and Support

A supervisor and two assistants manage the whole-bird bagging operation, including substituting for workers on breaks and supplying materials and product, not supplied by other support personnel, as needed along the line. The normal job assignments of the crew are shown in table 2.

Table 2.—Labor requirements, by function and productivity rates, to bag 4,800 broilers per hour[1]

Function	Number of workers	Birds per worker-hour [2]	Birds per worker-minute [3]	Worker-minutes per 100 birds [4]	Worker-hours per 1,000 birds [5]	Worker-hours per 100 boxes [6]
Hang birds in shackles	3	1,600	26.7	3.75	0.63	.75
Drain body cavity	1	4,800	80.0	1.25	.21	.25
Grade birds	1	4,800	80.0	1.25	.21	.25
Place bag and pad on birds	7	686	11.4	8.77	1.46	1.75
Seal bags	8	600	10.0	10.00	1.67	2.00
Make and transport boxes ..	5	960	16.0	6.25	1.04	1.25
Distribute birds	1	4,800	80.0	1.25	.21	.25
Feed birds to weigh stations	3	1,600	26.7	3.75	.63	.75
Weigh birds	3	1,600	26.7	3.75	.63	.75
Move boxes of birds	3	1,600	26.7	3.75	.63	.75
Seal and label boxes	1	4,800	80.0	1.25	.21	.25
Stamp boxes	2	2,400	40.0	2.50	.42	.50
Load boxes on pallets and transport to storage	3	1,600	26.7	3.75	.63	.75
Supervise and assist	3	1,600	26.7	3.75	.63	.75
Total or average	44	109.09	1.82	55.00	9.17	11.00

[1]12 birds per box.
[2]Number of birds packed per hour, divided by number of workers.
[3]Birds per worker-hour, divided by 60 minutes.
[4]100 birds, divided by birds per worker-minute.
[5]1,000 birds, divided by birds per worker-hour.
[6]100 boxes, 12 birds each, divided by total birds packed per hour, and the dividend multiplied by the number of workers.

Total Labor Requirements

The labor requirements are presented in table 2 for bagging and packing 4,800 birds per hour in the study plant. Two functions, placing the bags on the birds and sealing the bags are quite labor intensive, requiring a total of 15 workers. When bottlenecks or delays occur, they usually occur at those work stations. If the bag sealers do not keep up, the birds remain on the overhead conveyor and go through the complete cycle again, reducing the productivity of the entire crew.

The normal productivity rate for the bagging line, including a 10-percent allowance for lost time and fatigue, is 109 birds per worker-hour. At times, the line speed has to be decreased, especially when some of the trainees are working at crucial jobs or when giblets are being stuffed into body cavities.

A full crew of 44 people is more crucial to the bagging operation than to the icepacking operation because more of the crew is being fully utilized in the bagging operation at the present operating level.

Improved Icepacking Operation

The layout of the improved icepacking facilities and the primary work stations of personnel is shown in figure 7. The layout is designed to promote efficiency in the packing and handling of whole ready-to-cook broilers, while maintaining sufficient versatility to allow for the packing of other products after the short time necessary for changing the line form. Only the changes that are deemed to be highly cost effective are included. Sufficient space is allowed for the performance of each operation, although an operation may not be performed on all products. The packing line is designed to operate at 4,800 birds per hour because that speed is the prevalent one in the industry. However, the system probably could be expanded to operate at 6,000 birds per hour if some additional improvements were developed. The bagging operation is the most restrictive operation now.

Hanging and Grading

No changes are recommended for the hanging and grading stations or for the staffing requirements because no feasible improvements have been perfected.

Neck Stuffing

The neck-stuffing function is eliminated by the installation of an improved giblet-wrapping machine that can include necks in the giblet bag. Necks are stuffed into the body cavities as part of the giblet packs.

Giblet Packing and Stuffing

An automatic giblet-wrapping machine is shown in figure 7. This machine is located in the same general area as the giblet-bagging wheel is in the present operation (fig. 3). The automatic giblet-wrapping machine replaces both the giblet wheel and the pans used in giblet bagging, and four people and a supplier can wrap up to 6,000 giblets sets per hour. Four additional people, plus a helper, can stuff the giblets into the body cavities.

Each of the four giblet-machine operators loads a giblet item into a cup, thereby forming a set of giblets. Each giblet set is unloaded automatically onto a continuous paper surface. The paper is folded and cut to enclose individual sets of giblets, which are conveyed to the stuffing area. There they are removed from the belt conveyor and stuffed into the respective body cavities. The paper is supplied from a roll that will enclose approximately 7,200 sets of giblets.

By using the wrapping machine and the other modifications illustrated in figure 7, 10 people can wrap and stuff the giblets and necks, whereas, with the present equipment and facility arrangements, 20 people are required for the same functions.

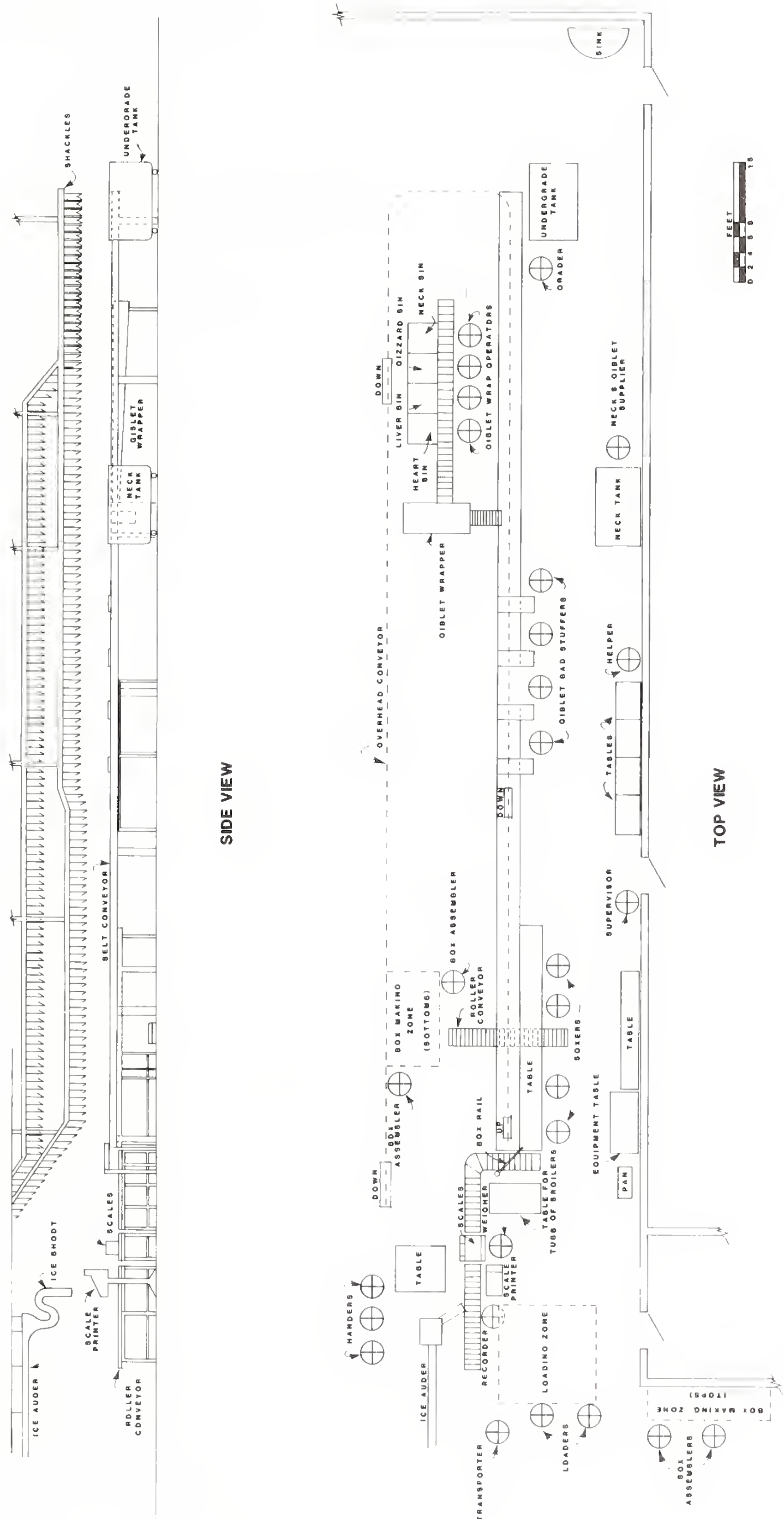


Figure 7.—Arrangement of facilities and work stations on the improved icepacking line.

At a cost of approximately $18,000, the wrapping machine is highly cost effective; its cost saving can completely offset its cost in less than 3 months.

Box Packing

Four workers remove birds from the shackles and place them in fiberboard boxes that are located on a table between the workers and the belt conveyor. The 1½- by 13-foot packing table is relocated to the opposite side of the belt conveyor (fig. 7) to allow more room for assembling boxes at a point close to the packing station. The assembled boxes are transported by a gravity-fed roller conveyor from the makeup station to the packing station. Normally, 22-23 birds are packed in each box. Then the filled box is pushed onto a roller conveyor and transported to the scales.

Unassembled boxes are stacked on pallets in the box-makeup area, where two people assemble (form and staple) the boxes and place them on the roller conveyor, which carries them under the belt conveyor to the box packers.

Box Weighing and Labeling

Boxes are manually pushed onto the scales and weighed. If the desired weight is exceeded, some of the birds are removed from the box and lighter weight one substituted. Conversely, if more weight is desired, heavier birds are substituted. The weigher has a supply of different-weight birds available in tubs located on a nearby table (fig. 7).

Several new items of equipment are recommended for the box weighing and labeling area to help increase productivity per worker-hour for this operation. New equipment and estimated costs are as follows:

Item	Cost
1 digital bench scale, 20″ × 20″	$2,835
1 stainless steel bench stand	280
1 data printer	7,330
1 adjustable stand	275
1 90-degree-curve roller conveyor	150
2 4-foot sections of rollery conveyor	320
Service contract	1,260
Installation/test/training	875
Subtotal	13,325
Ice auger and chute	5,500
Total	18,825

Both the scales and the data printer should be rugged in construction, capable of withstanding frequent washing with detergents and high pressure water, and fast and simple to operate. They should feature a balance detector to prevent the label from being printed prematurely and to prevent giving away product or short-changing customers. Also, the scales should feature an automated tare capability; thermal printing of clear, legible labels; complete production reports on demand; journal records; and choice of formats for labels. With the automated tare feature, tare is programmed for each product and automatically subtracted to provide a net weight display and printed label without operator calculation. Additionally, if the data printer can provide a pallet-total label, a label showing the sum of the net weight of all boxes on a pallet, it will serve as another check system. A journal-tape-record feature eliminates the need to manually record box weights by class, a task that requires a full-time worker in the present operation.

By eliminating the need for a labeler, a label preparer, and two box feeders, the annual labor cost can be reduced by $41,600 (four workers at $5 per hour, 2,080 hours per year), allowing recovery of the equipment cost in less than 6 months. Previous studies (*8*) and time checks in this study plant indicate that weighing and labeling requires approximately 0.22 worker-minute per box, well within the timeframe for one worker. The label is prepared by the data printer, and the new arrangement eliminates the need for the two box feeders.

When the weight of a box of broilers has been adjusted to the desired weight, the printer is activated, producing a label that will adhere to the box. After a box is weighed, it is pushed along the roller conveyor to the recorder, who attaches a label to the box. After attaching the label, the recorder pushes the box along the roller conveyor to a point under the ice chute, where ice is added to the box. According to one study (*9*, it takes 2.8 worker-hours to manually scoop ice from a bin into 1,000 boxes of poultry. In the modified operation the recorder adds ice, using a switch-controlled overhead ice auger and chute. After ice is added, the box is pushed along the roller conveyor to the loading area. The recorder feeds information into the data printer to print the label and provide adequate records.

Loading and Transporting

Two workers assemble box tops near the loading zone and push stacks of tops into the loading zone. Then two other workers place the tops on boxes and load them onto pallets. Another worker moves the pallet-loads of product to storage or to shipping with an electric pallet transporter or pallet jack.

Supervising and Support

A supervisor and an assistant manage the whole-bird packing operation. Additionally, the assistant serves as a helper to the giblet-bag stuffers. Both substitute for absent workers and those on break.

Total Labor Requirements

Estimated labor requirements, by function, are shown in table 3, after incorporation of the improved methods and facilities.

The study plant, or plants with similar situations, could achieve an estimated 36-percent reduction in labor requirements. That reduction would increase productivity from 109 to 171.4 birds per worker-hour when the packing line is operating at 4,800 birds per hour, assuming a 10-percent lost time and fatigue factor. An even greater increase in productivity could probably be achieved by increasing the line speed to approximately 6,000 birds per hour, which is the manufacturer's suggested operating speed for the giblet-bagging machines. At 6,000 birds per hour and present staffing, productivity would increase to 214 birds per worker-hour. Comparable increases have been achieved in the slaughtering and eviscerating departments of many plants.

Table 3.—Labor requirements, by function and productivity rates, to icepack 4,800 broilers per hour with improved methods and facilities[1]

Function	Number of workers	Birds per worker-hour [2]	Birds per worker-minute [3]	Worker-minutes per 100 birds [4]	Worker-hours per 1,000 birds [5]	Worker-hours per 100 boxes [6]
Hang birds in shackles	3	1,600	26.7	3.75	0.63	1.44
Grade birds	1	4,800	80.0	1.25	.21	.48
Bag giblets	4	1,200	20.0	5.00	.83	1.92
Stuff giblets	4	1,200	20.0	5.00	.83	1.92
Make boxes	2	2,400	40.0	2.50	.42	.96
Pack birds in boxes	4	1,200	20.0	5.00	.83	1.92
Weigh boxes of birds and record weights	2	2,400	40.0	2.50	.42	.96
Make box tops	2	2,400	40.0	2.50	.42	.96
Load boxes	2	2,400	40.0	2.50	.42	.96
Transport boxes to storage	1	4,800	80.0	1.25	.21	.48
Supervise and assist	3	1,600	26.7	3.75	.63	1.44
Total or average	28	171.43	2.86	35.00	5.83	13.42

[1] 23 birds per box.
[2] Number of birds packed per hour, divided by number of workers.
[3] Birds per worker-hour, divided by 60 minutes.
[4] 100 birds, divided by birds per worker-minute.
[5] 1,000 birds, divided by birds per worker-hour.
[6] 100 boxes, 23 birds each, divided by total birds packed per hour, and the dividend multiplied by the number of workers.

Facilities for an improved broiler-bagging operation and primary work station locations are illustrated in the layout in figure 8. Parameters used in developing the layout design consisted of (a) limiting the space and configuration of the improved line to that of the existing line; (b) maintaining sufficient versatility to pack other products after the short time necessary for changing the line equipment; (c) incorporating only the changes deemed to be highly cost effective; (d) maintaining sufficient space within the present whole-bird-packing-line area to perform each operation, even though some may not be performed on all products; and (e) ensuring that output can be increased as needed, up to at least 6,000 birds per hour.

Hanging, Draining, and Grading
No changes are recommended for the hanging, draining, and grading stations, and the manpower requirement would stay at the present level of three workers for hanging, one for draining, and one for grading.

Bagging and Bag Sealing
Automatic bagging machines improve the efficiency of the bagging and sealing functions. With one of the machines illustrated in figure 8, one worker can handle approximately 1,000 birds per hour, applying absorbent pads, bagging, and sealing bags. Both automatic and semiautomatic poultry-bagging machines are made by several national and international firms. Typically, the birds must be placed in a chute, where the legs are folded and the bird is mechanically pushed through the chute into a bag. With most of the same automatic machines, the bag is twisted and clipped or taped mechanically, whereas, with the semiautomatic machine, the sealing and clipping functions are performed manually. Using the semiautomatic machines, a good operator can bag and seal bags on approximately 600 birds per hour.

Using the automatic bird-wrapping machines outlined in figure 8, 5 machine operators and 1 supplier-helper could package the present volume of 4,800 birds per hour, whereas 16 people are required now to perform the same functions.

At a cost of approximately $97,500, the automatic bagging machines and conveyors are highly cost effective. The saving in labor cost, with only 6 workers—at a wage rate of $5 per hour—instead of the present 16 workers required, would offset the cost of the automatic equipment in slightly less than a year.

Weighing and Classing
The automatic poultry-bagging machines move the bagged birds to an 8-inch-wide belt conveyor system that takes them to the weighing and classing station. At that station, one of the three weighers lifts the birds from the belt conveyor and places them individually on the scales shown in figure 8. A weight-price, self-adhesive label in ejected by the scales equipped with

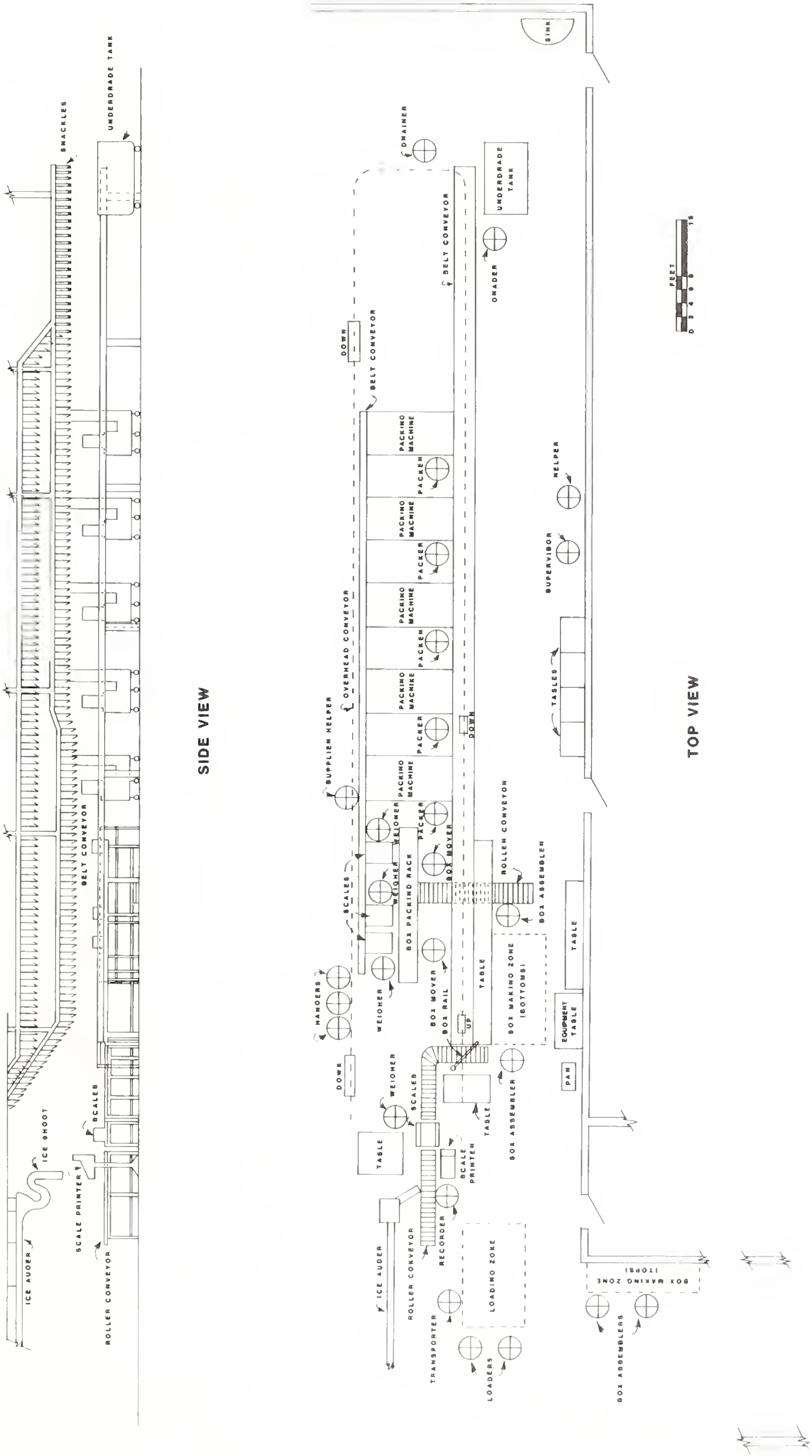


Figure 8.—Arrangement of facilities and work stations for the improved bagging and boxing line.

data printer, and the weigher attaches the label to the bird bag. Then the bird is placed, according to weight class, in the appropriate box in the three-level box-packing rack. The rack is located adjacent to the scales and has sufficient shelf space for holding 27 fiberboard boxes of either the 12- or 16-bird size. The rack's location gives each weigher easy access to nine boxes (three on each shelf) and facilitates convenient packing of all classes.

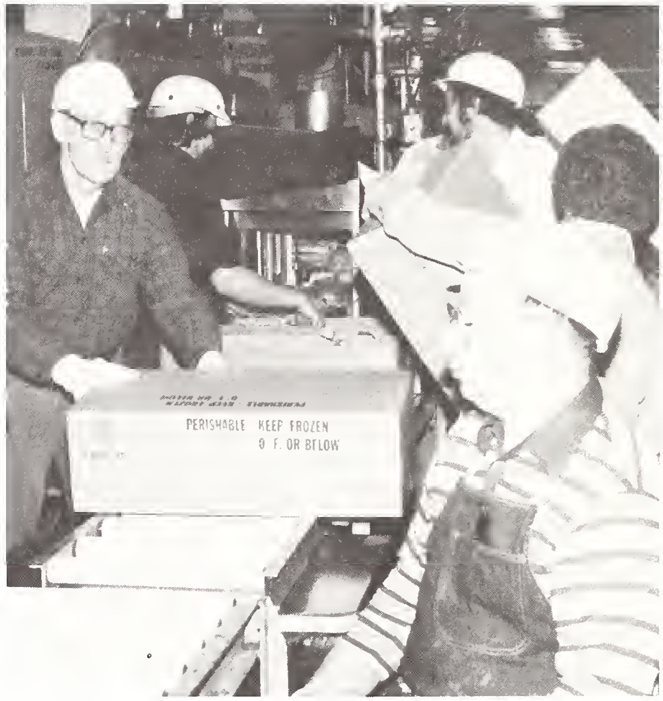
Box Moving
The empty boxes are supplied by the two box movers stationed on the opposite side of the rack from the weighers. The box movers carry the filled boxes from the rack to the 18-inch-wide belt conveyor located under the overhead shackle conveyor. Then they label an empty box for the needed weight class and place it in that slot in the rack. The box-packing rack and the scales with data printers were already in use at the study plant; therefore, no additional cost was involved.

Box Making
In figure 8, the location for making box bottoms has been relocated to a position between the equipment table and the 18-inch-belt conveyor to eliminate the need for manually transporting them, when formed, to the rack area. With this arrangement, the formed and stapled box bottoms can be placed on a 3- by 16-foot roller conveyor, which is tilted to move the boxes by gravity to the rack area.

Box tops are formed and stapled in the hallway, in the same proximity as in the existing operation. The box transporter would not be needed with this layout of operations because the bottoms can be moved to the point of use with the roller conveyor, and stacks of box tops have to be moved only a short distance.

Box Sealing and Labeling
Boxes filled with bagged and labeled birds are moved by the box movers from the box-packing rack to the 18-inch-belt conveyor, which transports them to a 2-foot-wide roller conveyor. A box rail across the roller conveyor at its intersection with the belt conveyor causes boxes to move along the roller conveyor as other boxes are pushed onto the roller conveyor by the belt conveyor.

The filled boxes travel along the roller conveyor to the scales. There the data printer, activated by the weigher, prints the weight, class, number of head, and other pertinent information on a self-adhering label. The recorder



attaches the label to the box. At the same time, these data are recorded in the computer memory, by order, for tabulation and reference. The computer can be useful in order assembly, invoice preparation, inventory, and control. Should the need arise, it can also help locate any product to be recalled or destroyed.

Loading and Transporting
Two workers apply the tops to the boxes and stack the filled boxes on pallets, inserting "two-by-four" lumber between layers of boxes as the pallet is loaded. Another worker moves the palletloads of product to storage or to shipping with an electric pallet transporter or pallet jack.

Supervising and Support
A supervisor and an assistant manage the whole-bird bagging operation, each of them substituting for absent workers when needed. Also, the assistant manager supplies bags to the bagging stations and moves tanks, boxes, equipment, and product as needed to keep the operation functioning smoothly.

Total Labor Requirements

Estimated labor requirements to bag, box, and label 4,800 whole RTC broilers per hour, after incorporation of the previously discussed improved methods and facilities, are shown, by function, in table 4. The figures reflect a 39-percent reduction in labor requirements resulting in an increase from 109 to 178 birds per worker-hour when the whole-bird bagging line is operating at 4,800 birds per hour, assuming a 10-percent allowance for lost time and fatigue. An increase in the line speed to 6,000 birds per hour with the facilities, equipment, and personnel discussed in the preceding sections of this report, could achieve an even greater increase in productivity. The equipment cannot operate smoothly at 6,000 birds per hour now, but it is anticipated that improvements will be developed by the manufacturers to facilitate this rate in the near future.

The figures shown in table 4 are estimated for the study plant and may not apply to plants with other levels of productivity. The management of each plant should evaluate its whole-bird packaging operation to see where improvements can be made, using this report as an example.

Assuming a 39-percent labor reduction for the 4.7-billion-pound portion of the national broiler industry, and a wage rate—including fringe benefits—of $6.00 per hour, the productivity increase from 109 birds per worker-hour to 178 birds per worker-hour would amount to a $36.5 million savings. Assuming 50-percent implementation, the industry would save nearly $18.3 million annually.

Table 4.—Labor requirements, by function and productivity rates, to bag 4,800 birds per hour with improved methods and facilities[1]

Function	Number of workers	Birds per worker-hour [2]	Birds per worker-minute [3]	Worker-minutes per 100 birds [4]	Worker-hours per 1,000 birds [5]	Worker-hours per 100 boxes [6]
Hang birds in shackles	3	1,600	26.7	3.75	0.63	.75
Drain body cavity	1	4,800	80.0	1.25	.21	.25
Grade birds	1	4,800	80.0	1.25	.21	.25
Bag and seal with machines	6	800	13.3	7.5	1.25	1.5
Weigh and class	3	1,600	26.7	3.75	.63	.75
Move boxes	2	2,400	40.0	2.50	.42	.50
Make boxes	4	1,200	20.0	5.00	.83	1.00
Weigh and label boxes and record weights	2	2,400	40.0	2.50	.42	.50
Load boxes	2	2,400	40.0	2.50	.42	.50
Transport boxes	1	4,800	80.0	1.25	.21	.25
Supervise and provide support	2	2,400	40.0	2.50	.42	.50
Total or average	27	177.78	2.96	33.75	5.63	6.75

[1]12 birds per box. Some birds are packed 16 per box.
[2]Number of birds packed per hour, divided by number of workers.
[3]Birds per worker-hour, divided by 60 minutes.
[4]100 birds, divided by birds per worker-minute.
[5]1,000 birds, divided by birds per worker-hour.
[6]100 boxes, 12 birds each, divided by total birds packed per hour, and the dividend multiplied by the number of workers.

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Appendix

Description of Methods-Time-Measurement Technique, with an Illustrated Analyses Form

Methods-Time Measurement (MTM) is one of the procedures for developing accurate time values for a manual operation involving short, rapidly recurring work cycles. The MTM breaks any manual operation into the basic motions required to perform it and assigns to each motion a predetermined time standard that is determined by the nature of the motion and the conditions under which it is made. The predetermined time units used by MTM are identified as Time-Measurement Units (TMU's). A TMU is equal to 0.00001 hour, 0.0006 minute, or 0.036 second and is used to calculate the time values in hours, minutes, or seconds. A sample MTM analyses form (page 23) includes a line at the bottom for adding a fatigue allowance to the total TMU's. The column headings in the form refer to the operation being evaluated (listed under Description), the pertinent hand—left (LH) or right (RH)—used for the operation, and the time (TMU) required to accomplish the operation. Letter symbols can be listed in each entry under LH and RH to identify the MTM factor; for example, R is reach, G is grasp, and so forth. Figure symbols can be listed in each entry to further identify the operation as to degree of complexity, length of reach, and so forth. The entry listed should be the longest time required to accomplish the operation. That time value, listed under TMU, is the controlling value for the operation and is used in calculating the total TMU for the element.

The MTM organization responsible for the proper use of this methods-time-measurement technique discourages its use without a thorough understanding of the application of the values that have been developed; consequently, those values are not reproduced here. Inquiries regarding the technique should be addressed to the MTM organization (*6*). The MTM tables are: "Copyrighted by the MTM Association for Standards and Research. No reprint permission without written consent from the MTM Association, 16-01 Broadway, Fair Lawn, NJ 10710."

Methods-Time Measurement MTM-1 Application Data

OPERATION | ELEMENT NO.

METHOD | ANALYST

CLASS | DATE

Description (left hand)	NO		LH		TMU		RH		NO		(right hand) Description

PLUS 10% FATIGUE ALLOWANCE

TOTAL TMU

TMU × 10 × .00006 = MIN/10 BIRDS

10 BIRDS ÷ MIN = BIRDS/MIN

METHODS-TIME MEASUREMENT
MTM-I APPLICATION DATA

1 TMU	=	.00001 hour	1 hour	=	100,000.0 TMU
	=	.0006 minute	1 minute	=	1,666.7 TMU
	=	.036 seconds	1 second	=	27.8 TMU

Do not attempt to use this chart or apply Methods-Time Measurement in any way unless you understand the proper application of the data. This statement is included as a word of caution to prevent difficulties resulting from misapplication of the data.

MTM ASSOCIATION FOR STANDARDS AND RESEARCH
16-01 Broadway
Fair Lawn, N.J. 07410

MTMA 101
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TABLE I – REACH – R

Distance Moved Inches	Time TMU A	Time TMU B	Time TMU C or D	Time TMU E	Hand In Motion A	Hand In Motion B	CASE AND DESCRIPTION
3/4 or less	2.0	2.0	2.0	2.0	1.6	1.6	A Reach to object in fixed location, or to object in other hand or on which other hand rests.
1	2.5	2.5	3.6	2.4	2.3	2.3	
2	4.0	4.0	5.9	3.8	3.5	2.7	
3	5.3	5.3	7.3	5.3	4.5	3.6	B Reach to single object in location which may vary slightly from cycle to cycle.
4	6.1	6.4	8.4	6.8	4.9	4.3	
5	6.5	7.8	9.4	7.4	5.3	5.0	
6	7.0	8.6	10.1	8.0	5.7	5.7	
7	7.4	9.3	10.8	8.7	6.1	6.5	C Reach to object jumbled with other objects in a group so that search and select occur.
8	7.9	10.1	11.5	9.3	6.5	7.2	
9	8.3	10.8	12.2	9.9	6.9	7.9	
10	8.7	11.5	12.9	10.5	7.3	8.6	
12	9.6	12.9	14.2	11.8	8.1	10.1	
14	10.5	14.4	15.6	13.0	8.9	11.5	D Reach to a very small object or where accurate grasp is required.
16	11.4	15.8	17.0	14.2	9.7	12.9	
18	12.3	17.2	18.4	15.5	10.5	14.4	
20	13.1	18.6	19.8	16.7	11.3	15.8	
22	14.0	20.1	21.2	18.0	12.1	17.3	E Reach to indefinite location to get hand in position for body balance or next motion or out of way.
24	14.9	21.5	22.5	19.2	12.9	18.8	
26	15.8	22.9	23.9	20.4	13.7	20.2	
28	16.7	24.4	25.3	21.7	14.5	21.7	
30	17.5	25.8	26.7	22.9	15.3	23.2	
Additional	0.4	0.7	0.7	0.6			TMU per inch over 30 inches

TABLE II – MOVE – M

Distance Moved Inches	Time TMU A	Time TMU B	Time TMU C	Hand In Motion B	Wt. Allowance Wt. (lb.) Up to	Wt. Allowance Dynamic Factor	Wt. Allowance Static Constant TMU	CASE AND DESCRIPTION
3/4 or less	2.0	2.0	2.0	1.7				
1	2.5	2.9	3.4	2.3	2.5	1.00	0	
2	3.6	4.6	5.2	2.9				A Move object to other hand or against stop.
3	4.9	5.7	6.7	3.6	7.5	1.06	2.2	
4	6.1	6.9	8.0	4.3				
5	7.3	8.0	9.2	5.0	12.5	1.11	3.9	
6	8.1	8.9	10.3	5.7				
7	8.9	9.7	11.1	6.5	17.5	1.17	5.6	
8	9.7	10.6	11.8	7.2				
9	10.5	11.5	12.7	7.9	22.5	1.22	7.4	B Move object to approximate or indefinite location.
10	11.3	12.2	13.5	8.6				
12	12.9	13.4	15.2	10.0	27.5	1.28	9.1	
14	14.4	14.6	16.9	11.4				
16	16.0	15.8	18.7	12.8	32.5	1.33	10.8	
18	17.6	17.0	20.4	14.2				
20	19.2	18.2	22.1	15.6	37.5	1.39	12.5	
22	20.8	19.4	23.8	17.0				
24	22.4	20.6	25.5	18.4	42.5	1.44	14.3	C Move object to exact location.
26	24.0	21.8	27.3	19.8				
28	25.5	23.1	29.0	21.2	47.5	1.50	16.0	
30	27.1	24.3	30.7	22.7				
Additional	0.8	0.6	0.85		TMU per inch over 30 inches			

TABLE III A – TURN – T

Weight	Time TMU for Degrees Turned										
	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
Small – 0 to 2 Pounds	2.8	3.5	4.1	4.8	5.4	6.1	6.8	7.4	8.1	8.7	9.4
Medium – 2.1 to 10 Pounds	4.4	5.5	6.5	7.5	8.5	9.6	10.6	11.6	12.7	13.7	14.8
Large – 10.1 to 35 Pounds	8.4	10.5	12.3	14.4	16.2	18.3	20.4	22.2	24.3	26.1	28.2

TABLE III B – APPLY PRESSURE – AP

FULL CYCLE			COMPONENTS		
SYMBOL	TMU	DESCRIPTION	SYMBOL	TMU	DESCRIPTION
APA	10.6	AF + DM + RLF	AF	3.4	Apply Force
			DM	4.2	Dwell, Minimum
APB	16.2	APA + G2	RLF	3.0	Release Force

TABLE IV – GRASP – G

TYPE OF GRASP	Case	Time TMU	DESCRIPTION	
PICK-UP	1A	2.0	Any size object by itself, easily grasped	
	1B	3.5	Object very small or lying close against a flat surface	
	1C1	7.3	Diameter larger than 1/2"	Interference with Grasp on bottom and one side of nearly cylindrical object.
	1C2	8.7	Diameter 1/4" to 1/2"	
	1C3	10.8	Diameter less than 1/4"	
REGRASP	2	5.6	Change grasp without relinquishing control	
TRANSFER	3	5.6	Control transferred from one hand to the other.	
SELECT	4A	7.3	Larger than 1" x 1" x 1"	Object jumbled with other objects so that search and select occur.
	4B	9.1	1/4" x 1/4" x 1/8" to 1" x 1" x 1"	
	4C	12.9	Smaller than 1/4" x 1/4" x 1/8"	
CONTACT	5	0	Contact, Sliding, or Hook Grasp.	

EFFECTIVE NET WEIGHT			
Effective Net Weight (ENW)	No. of Hands	Spatial	Sliding
	1	W	W x F_c
	2	W/2	W/2 x F_c

W = Weight in pounds
F_c = Coefficient of Friction

TABLE V – POSITION* – P

CLASS OF FIT		Symmetry	Easy To Handle	Difficult To Handle
1–Loose	No pressure required	S	5.6	11.2
		SS	9.1	14.7
		NS	10.4	16.0
2–Close	Light pressure required	S	16.2	21.8
		SS	19.7	25.3
		NS	21.0	26.6
3–Exact	Heavy pressure required.	S	43.0	48.6
		SS	46.5	52.1
		NS	47.8	53.4

SUPPLEMENTARY RULE FOR SURFACE ALIGNMENT	
P1SE per alignment >1/16 ≤1/4"	P2SE per alignment ≤1/16"

*Distance moved to engage–1" or less

TABLE VI – RELEASE – RL

Case	Time TMU	DESCRIPTION
1	2.0	Normal release performed by opening fingers as independent motion
2	0	Contact Release

TABLE VII – DISENGAGE – D

CLASS OF FIT	HEIGHT OF RECOIL	EASY TO HANDLE	DIFFICULT TO HANDLE
1–LOOSE–Very slight effort, blends with subsequent move	Up to 1"	4.0	5.7
2–CLOSE–Normal effort, slight recoil.	Over 1" to 5"	7.5	11.8
3–TIGHT–Considerable effort, hand recoils markedly	Over 5" to 12"	22.9	34.7

SUPPLEMENTARY

CLASS OF FIT	CARE IN HANDLING	BINDING
1–LOOSE	Allow Class 2	————
2–CLOSE	Allow Class 3	One G2 per Bind
3–TIGHT	Change Method	One APB per Bind

TABLE VIII – EYE TRAVEL AND EYE FOCUS – ET AND EF

Eye Travel Time = $15.2 \times \frac{T}{D}$ TMU, with a maximum value of 20 TMU.

where T = the distance between points from and to which the eye travels.
D = the perpendicular distance from the eye to the line of travel T.

Eye Focus Time = 7.3 TMU.

SUPPLEMENTARY INFORMATION

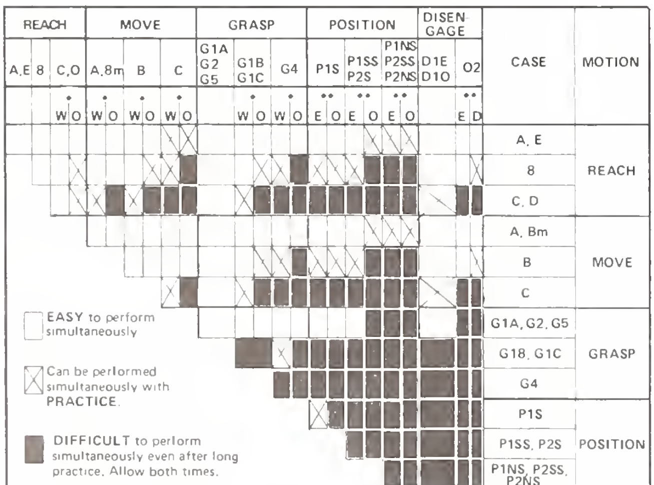
– Area of Normal Vision = Circle 4" in Diameter 16" from Eyes

– Reading Formula = 5.05 N Where N = The Number of Words

TABLE IX – BODY, LEG, AND FOOT MOTIONS

TYPE		SYM8OL	TMU	OISTANCE	OESCRIPTION
LEG-FOOT MOTION		FM	8.5	To 4"	Hinged at ankle.
		FMP	19.1	To 4"	With heavy pressure.
		LM__	7.1	To 6"	Hinged at knee or hip in any direction.
			1.2	Ea. add'l inch	
HORIZONTAL MOTION	SIOE STEP	SS__C1	•	<12"	Use Reach or Move time when less than 12". Complete when leading leg contacts floor.
			17.0	12"	
			0.6	Ea. add'l inch	
		SS__C2	34.1	12"	Lagging leg must contact floor before next motion can be made.
			1.1	Ea. add'l inch	
	TURN 8OOY	T8C1	18.6	——	Complete when leading leg contacts floor.
		T8C2	37.2	——	Lagging leg must contact floor before next motion can be made
	WALK	W__FT	5.3	Per Foot	Unobstructed.
		W__P	15.0	Per Pace	Unobstructed.
		W__PO	17.0	Per Pace	When obstructed or with weight.
VERTICAL MOTION		SIT	34.7	——	From standing position.
		STO	43.4	——	From sitting position.
		8,S,KOK	29.0	——	8end, Stoop, Kneel on One Knee.
		A8,AS,AKOK	31.9	——	Arise from Bend, Stoop, Kneel on One Knee
		KBK	69.4	——	Kneel on 8oth Knees.
		AK8K	76.7	——	Arise from Kneel on 8oth Knees.

TABLE X – SIMULTANEOUS MOTIONS



MOTIONS NOT INCLUDED IN A8OVE TABLE

TURN–Normally EASY with all motions except when TURN is controlled or with OISENGAGE
APPLY PRESSURE–May be EASY, PRACTICE, or OIFFICULT. Each case must be analyzed.
POSITION–Class 3–Always OIFFICULT
OISENGAGE–Class 3–Normally OIFFICULT
RELEASE–Always EASY
OISENGAGE–Any class may be DIFFICULT if care must be exercised to avoid injury or damage to object.

*W = Within the area of normal vision.
O = Outside the area of normal vision.
**E = EASY to Handle.
O = DIFFICULT to Handle.

SUPPLEMENTARY MTM DATA

TABLE 1 – POSITION – P

Class of Fit and Clearance	Case of † Symmetry	Align Only	Oepth of Insertion (per ¼") 0 >0≤1/8"	2 >1/8≤¾	4 >¾≤1¼	6 >1¼≤1¾
21 .150" – .350"	S	3.0	3.4	6.6	7.7	8.8
	SS	3.0	10.3	13.5	14.6	15.7
	NS	4.8	15.5	18.7	19.8	20.9
22 .025" – .149"	S	7.2	7.2	11.9	13.0	14.2
	SS	8.0	14.9	19.6	20.7	21.9
	NS	9.5	20.2	24.9	26.0	27.2
23* .005" – .024"	S	9.5	9.5	16.3	18.7	21.0
	SS	10.4	17.3	24.1	26.5	28.8
	NS	12.2	22.9	29.7	32.1	34.4

*8INDING–Add observed number of Apply Pressures.
DIFFICULT HANOLING–Add observed number of G2's.

†Determine symmetry by geometric properties, except use S case when object is oriented prior to preceding Move.

TABLE 1A – SECONDARY ENGAGE – E2

CLASS OF FIT	DEPTH OF INSERTION (PER 1/4") 2	4	6
21	3.2	4.3	5.4
22	4.7	5.8	7.0
23	6.8	9.2	11.5

TABLE 2 – CRANK (LIGHT RESISTANCE) – C

OIAMETER OF CRANKING (INCHES)	TMU (T) PER REVOLUTION	OIAMETER OF CRANKING (INCHES)	TMU (T) PER REVOLUTION
1	8.5	9	14.0
2	9.7	10	14.4
3	10.6	11	14.7
4	11.4	12	15.0
5	12.1	14	15.5
6	12.7	16	16.0
7	13.2	18	16.4
8	13.6	20	16.7

FORMULAS

A. CONTINUOUS CRANKING (Start at beginning and stop at end of cycle only)

TMU = [(NxT)+5.2]+F+C

8. INTERMITTENT CRANKING (Start at beginning and stop at end of each revolution

TMU = [(T+5.2) F+C]•N

C = Static component TMU weight allowance constant from move table
F = Dynamic component weight allowance factor from move table
N = Number of revolutions
T = TMU per revolution (Type III Motion)
5.2 = TMU for start and stop

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